

## POPULATION TREND OF ADULT BALD EAGLES IN SOUTHEAST ALASKA, 1967–97

MICHAEL J. JACOBSON AND JOHN I. HODGES

*U.S. Fish and Wildlife Service, 3000 Vintage Boulevard, Suite 240, Juneau, AK 99801-7100 U.S.A.*

**ABSTRACT.**—Six aerial surveys to estimate the population size of adult Bald Eagles (*Haliaeetus leucocephalus*) in southeast Alaska were conducted from 1967–97. A stratified random sampling method was used, focusing on plots 166 km<sup>2</sup> in size. All surveys were flown in late April and early May when egg laying and early incubation were in progress. A fitted regression line ( $P = 0.02$ ) indicated the adult Bald Eagle population increased 92% during the survey period, from 6941 in 1967 to 13 327 in 1997. However, we detected no significant population differences from 1982–97, which suggested the population may have begun to stabilize. The increase of the adult Bald Eagle population in southeast Alaska probably represents a recovery from the effects of the 1917–53 eagle bounty in Alaska when as many as 150 000 Bald Eagles were killed. The later establishment of protection zones at eagle nest trees and other key waterfront habitat on national forest lands (80% of the land base) may have helped allow the population to increase.

**KEY WORDS:** *Bald Eagle, Haliaeetus leucocephalus; southeast Alaska; population trend; aerial surveys; random plot sampling.*

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### Tendencia poblacional de las águilas calvas en el sureste de Alaska, 1967–97

**RESUMEN.**—Seis monitoreos aéreos para estimar el tamaño de la población fueron llevados a cabo en Alaska entre 1967–97. Un método de muestreo estratificado al azar fué utilizado mediante parcelas de 166 km<sup>2</sup> de tamaño. Todos los vuelos fueron realizados hacia finales de Abril y principios de Mayo durante la época de anidación e incubación. Una regresión lineal ( $P = 0.02$ ) indicó que la población se incrementó en un 92% durante el período de investigación de 6941 en 1967 a 13 327 en 1997. Sin embargo no detectamos ninguna diferencia poblacional significativa entre 1982–97, lo que sugiere que quizás la población ha comenzado a estabilizarse. El incremento en la población adulta en el sureste de Alaska probablemente representa una recuperación de los efectos de incentivos de caza entre 1917–53, en donde 150 000 águilas calvas fueron eliminadas. El reciente establecimiento de medidas de protección en las zonas de árboles de anidación y en habitats acuáticos en tierras de bosques nacionales (80% de estos) probablemente ha permitido el incremento de la población.

[Traducción de César Márquez]

Bald Eagles (*Haliaeetus leucocephalus*) are at their greatest abundance along the northern Pacific coast of North America, reaching highest densities in southeast Alaska, Prince William Sound and coastal British Columbia (King et al. 1972, Hodges et al. 1979, 1984, Bowman et al. 1995, 1997). The first aerial survey to provide an estimate of the adult Bald Eagle population in southeast Alaska was conducted in 1967. We completed the sixth comparable survey in 1997. With roughly 24 000 km of coastal shoreline in southeast Alaska, an aerial survey of the total shoreline was not practical. Stratified random sampling provided an accurate and repeatable method to estimate the numbers of adult bald eagles present in the breeding season.

### METHODS

King et al. (1972) divided the entire coastline of southeast Alaska into 488 plots, each 166 km<sup>2</sup>. From these, 30 plots were chosen at random, and each plot was classified into one of three strata (low, medium, high) based on the complexity of shoreline habitat within the plot and the expected density of eagles (Hodges et al. 1979, 1984). The stratified random sample of 30 plots was then used to extrapolate numbers of adult Bald Eagles for all of southeast Alaska. The same 30 plots have been surveyed six times by fixed-wing aircraft over a span of 30 yr: 1967, 1977, 1982, 1987, 1992 and 1997 (Fig. 1).

Adult Bald Eagles, with their large size and distinct white heads and tails, contrasted well against the dark spruce-hemlock coastal forest found in southeast Alaska. Perched immature eagles, with dark plumage; were difficult to see and, thus, we expected to observe a low percentage of them. However, since 1982, we have tried to estimate the percentage of immature eagles in the pop-

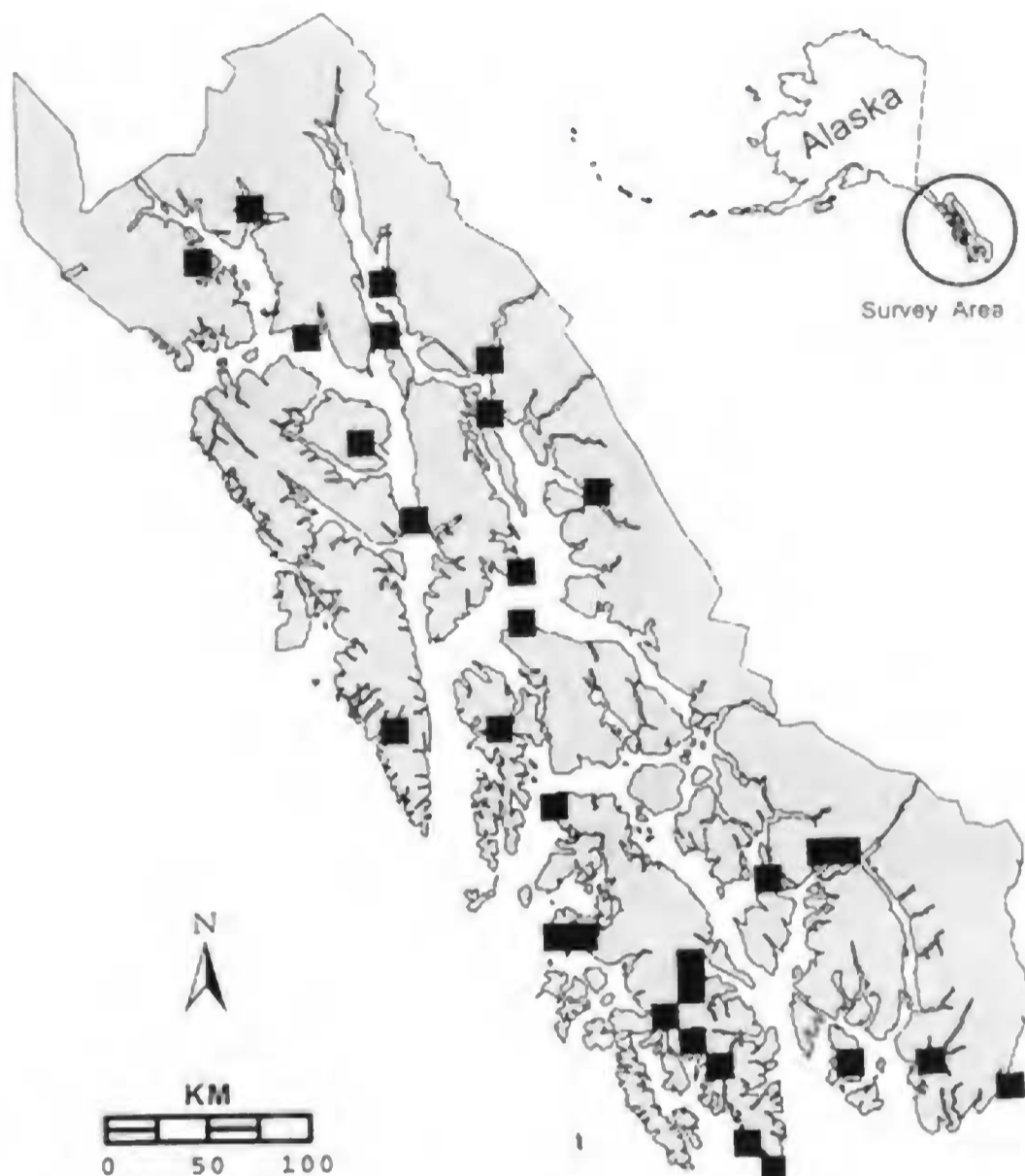


Figure 1. Location of 30 randomly selected plots surveyed for Bald Eagles in southeast Alaska in 1967, 1977, 1982, 1987, 1992 and 1997. These plots were used to estimate the population size of adult eagles in all of southeast Alaska.

ulation by recording the proportion of immature and adult eagles observed flying (Bowman et al. 1997, Hodges et al. 1984). Assuming all ages were equally visible while they were flying, and all ages were as likely to be flying, the proportion of flying immatures to flying adults provided an estimate of the percentage of immature birds in the population.

A turbine DeHavilland Beaver aircraft on amphibious floats was flown for every survey except 1967 when a Cessna 180 was used. Surveys were flown at an average altitude of 90 m and airspeed of 160 km/hr. All surveys were conducted in late April and early May when many adult eagles were near nest sites. Egg laying by Bald Eagles in southeast Alaska usually takes place during mid- to late-April, with hatching in late May and early June (U.S. Fish and Wildl. Serv., unpubl. data). Total flight hours for the six surveys varied from 32.0–37.8, with differences attributed to changing transit times. The observer and pilot both searched for eagles and the observer recorded observations directly onto 1:63 360 scale U.S. Geological Survey maps. The aircraft was flown along shorelines in a direction to provide optimum visibility for the observer in the right front seat.

Statistical procedures included stratified random sample, simple linear regression, and paired *t*-test (Snedecor

and Cochran 1967). Confidence limits on estimates of the percentage of all flying eagles that were immatures were calculated assuming independence and a binomial distribution (Fowler and Cohen 1986).

## RESULTS

A simple linear regression of the six survey points from 1967–97 indicated the adult Bald Eagle population in southeast Alaska increased an estimated 92% during that period (Fig. 2). The regression line placed the adult population at 6941 in 1967. The 1997 predicted value of  $13\,327 \pm 2592$  (95% confidence limits) equated to 0.55 adults per km of shoreline. Actual individual population estimates increased from 7230 adult eagles in 1967 to 12 026 eagles in 1997 (Table 1). A paired *t*-test, using plots as sample units, failed to detect significant population differences between the 1982–97 surveys. From 1982–97, immature eagles averaged  $13.3\% \pm 4.7\%$  of all eagles seen flying (Table 2).

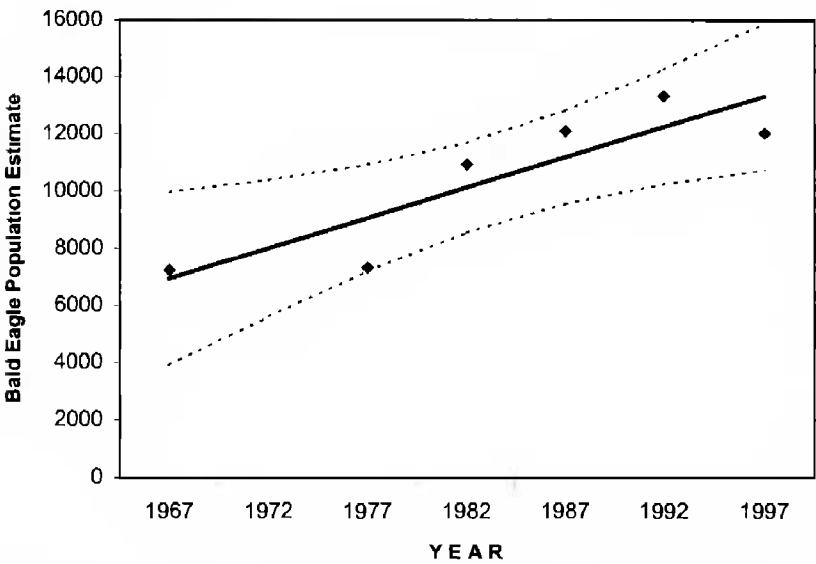


Figure 2. Population estimates calculated from aerial surveys of adult Bald Eagles in southeast Alaska in 1967–97. The solid line indicates the fitted regression line ( $P = 0.02$ ) and the 95% confidence limits are shown as dashed lines.

DISCUSSION

Our surveys proved to be a feasible way of monitoring the trend in the Alaskan Bald Eagle population over a broad area. The increase in the adult segment of the Bald Eagle population in southeast Alaska probably represented a recovery from the effects of the eagle bounty which occurred between 1917–53. Bounties were offered on the erroneous assumption that eagles seriously impacted the salmon and fur industries. During that period, as many as 150 000 Bald Eagles were killed in Alaska, with the majority coming from the southeast region (King et al. 1972). Hansen and Hodges (1985) suggested that the eagle population was greatly reduced during the bounty period and may have rebounded since that time. Although our data have shown a dramatic increase in the Bald Eagle population since 1967, the estimated decline in 1997 possibly indicated that the population has begun to stabilize.

The estimated population totals are minimum estimates since some adult eagles were undoubtedly missed during surveys. Bowman et al. (1993) developed an estimate of visibility bias for Bald Eagles in Alaska’s Prince William Sound, an area of coastal habitat similar to that found in southeast Alaska. Using radio-tagged Bald Eagles, they estimated that they would have seen an adult eagle in 68% of observations during a typical population survey. Applying this correction factor to the regression line prediction for 1997 would give a pop-

Table 1. Population estimates of adult Bald Eagles in southeast Alaska during spring of 1967, 1977, 1982, 1987, 1992 and 1997. Stratified random sampling was used, all plots were 166 km<sup>2</sup> in size.

YEAR	POPULATION ESTIMATE	STANDARD ERROR of ESTIMATE
1967	7230	458
1977	7329	457
1982	10 934	1606
1987	12 075	1219
1992	13 340	1185
1997	12 026	1554

ulation of 19 599 adult Bald Eagles in southeast Alaska.

In southeast Alaska, the proportion of flying immatures to flying adults was lower than reported in other coastal areas. Bowman et al. (1997) found immatures comprised 29.2% of all eagles seen flying during similar population surveys at Prince William Sound in 1982, 1989, 1990, 1991 and 1995. Hodges et al. (1984) reported immatures were 27% of all flying eagles during a 1980 survey of coastal British Columbia. More emphasis on the development of visibility correction factors could improve future estimates of adult and immature eagle numbers in southeast Alaska.

Eagles were widely distributed throughout the study area during all surveys. It is possible that eagles concentrating at feeding areas could have influenced our data; however, we rarely encountered this situation. On most surveys, we attempted to search for possible feeding concentrations outside the plots, but did not find large enough numbers of eagles to suggest the possibility of a substantial bias in our estimates.

Industrial scale clearcut logging began in south-

Table 2. Age ratios of Bald Eagles seen flying during population surveys in southeast Alaska in 1982, 1987, 1992 and 1997.

YEAR	NO. IM-MATURES	NO. ADULTS	% IM-MATURES	±95% CI
1982	4	58	6.5	6.2
1987	12	58	17.1	9
1992	8	37	17.8	11.4
1997	4	30	11.8	11
All years	28	183	13.3	4.7

east Alaska at about the same time the eagle bounty ended. Early logging practices sometimes included the removal of easily attainable old-growth timber along the waterfront, the same area where most eagles are found (Hodges and Robards 1982). Since 1968, a cooperative agreement between the U.S. Fish and Wildlife Service and the U.S. Forest Service (USFS) has provided for a protection zone of 100 m radius around each Bald Eagle nest tree identified on national forest lands (80% of the land base) in southeast Alaska. Later changes to the agreement added protection of eagle perching and roosting habitat. The USFS now restricts most timber harvest within 300 m of the beach (USDA Forest Service 1997). Logging practices on private lands (10% of the land base) have been less restrictive and, therefore, less successful in retaining nest tree buffer zones and protecting other key waterfront habitat for eagles. Nevertheless, protective measures across the majority of southeast Alaska may have helped allow the Bald Eagle population to increase since the elimination of the bounty.

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